

CLAIMS

What is claimed is:

1. A photoactive electronic device comprising:
 - 5 (a) an anode;
 - (b) a cathode, said cathode having a work function energy level E_3 ;
 - (c) a photoactive layer positioned between said anode and said cathode, said photoactive layer comprising a cyclometalated complex of a transition metal, said cyclometalated complex having a LUMO energy level E_2 and a HOMO energy level E_4 ; and
 - 10 (d) an electron transport and/or anti-quenching layer positioned between said cathode and said photoactive layer, said electron transport and/or anti-quenching layer having a LUMO energy level E_1 and a HOMO energy level E_5 ,
- 15 with the proviso that:
 - (1) $E_1 - E_3 < 1V$,
 - (2) $E_1 - E_2 > -1V$, and
 - (4) $E_4 - E_5 > -1V$.
- 20 2. The device of Claim 1 wherein $E_1 - E_2 > 0$.
3. The device of Claim 1 wherein $E_4 - E_5 > 0$.
4. The device of Claim 1 wherein said electron transport and/or anti-quenching layer has an electron mobility of at least $10^{-7} \text{ cm}^2/(\text{V}\cdot\text{sec})$.
- 25 5. The device of Claim 1 wherein the electron transport and/or anti-quenching layer comprises a phenanthroline derivative.
6. The device of Claim 5 wherein the phenanthroline derivative has Formula II shown in Figure 4, wherein:
 - R¹ and R² are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, 30 aryl, heteroaryl, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d;
 - a, b, c, and d are 0 or an integer such that a+b = 2n + 1, and c + d = 5;
 - n is an integer;
 - x is 0 or an integer from 1 through 3; and
- 35 y is 0, 1 or 2;
- with the proviso that there is at least one substituent on an aromatic group selected from F, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d.

7. The device of Claim 6, wherein n is an integer from 1 through 12.

8. The device of Claim 5 wherein the phenanthroline derivative is selected from Formulae II(a) through II(i) in Figure 5.

5 9. The device of Claim 5 wherein the phenanthroline derivative has Formula III(a), shown in Figure 6, wherein:

R¹ and R² are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, aryl, heteroaryl, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d;

10 R³ is the same or different at each occurrence and is selected from a single bond and a group selected from alkylene, heteroalkylene, arylene, heteroarylene, arylenealkylene, and heteroarylenealkylene;

Q is selected from a single bond and a multivalent group;

15 m is an integer equal to at least 2;

p is 0 or 1;

and

x is 0 or an integer from 1 through 3.

10. The device of Claim 9, wherein:

20 m is an integer from 2 through 10;

n is in integer from 1 through 12; and

with the proviso that when Q is a single bond, p is 0.

11. The device of Claim 5, wherein the phenanthroline derivative has Formula III(b), shown in Figure 6, wherein:

25 R¹ and R² are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, aryl, heteroaryl, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d;

R³ is the same or different at each occurrence and is selected from a single bond and a group selected from alkylene, heteroalkylene, arylene, heteroarylene, arylenealkylene, and heteroarylenealkylene;

30 Q is selected from a single bond and a multivalent group;

m is an integer equal to at least 2;

p is 0 or 1;

35 and

x is 0 or an integer from 1 through 3.

12. The device of Claim 1 wherein the electron transport and/or anti-quenching layer comprises a quinoxaline derivative.

13. The device of Claim 12 wherein the quinoxaline derivative has Formula V, shown in Figure 8, wherein:

R⁴ and R⁵ are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, aryl, heteroaryl, alkylenearyl, alkenylaryl, alkynylaryl, alkyleneheteroaryl, alkenylheteroaryl, alkynylheteroaryl, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d, or both of R⁵ together may constitute an arylene or heteroarylene group;

10 a, b, c, and d are 0 or an integer such that a+b = 2n + 1, and c + d = 5;

n is an integer; and

w is 0 or an integer from 1 through 4.

14. The device of Claim 13 wherein n is an integer from 1 through 15 12.

15. The device of Claim 12 wherein the quinoxaline derivative is selected from Formulae V(a), V(b), V(d) through V(i) and V(k) through V(ag) in Figure 9.

16. The device of Claim 12, wherein the quinoxaline derivative is 20 selected from Formulae V(c) and V(j) in Figure 9.

17. The device of Claim 12 wherein the quinoxaline derivative has Formula VI, shown in Figure 10, wherein:

R⁴ and R⁵ are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, 25 aryl, heteroaryl, alkylenearyl, alkenylaryl, alkynylaryl, alkyleneheteroaryl, alkenylheteroaryl, alkynylheteroaryl, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d, or both of R⁵ together may constitute an arylene or heteroarylene group;

30 R³ is the same or different at each occurrence and is selected from a single bond and a group selected from alkylene, heteroalkylene, arylene, heteroarylene, arylenealkylene, and heteroarylenealkylene;

Q is selected from a single bond and a multivalent group;

35 a, b, c, and d are 0 or an integer such that a+b = 2n + 1, and c + d = 5;

m is an integer equal to at least 2;

n is an integer; and

p is 0 or 1.

18. The device of Claim 17, wherein:

m is an integer from 2 through 10;

n is an integer from 1 through 12; and

5 p is 0.

19. The device of Claim 12 wherein the quinoxaline derivative is selected from Formulae VI(b) through VI(g) and VI(i) through VI(k) in Figure 11.

20. The device of Claim 12 wherein the quinoxaline derivative is selected from Formulae VI(a), VI(h), VI(l) and VI(m) in Figure 11.

10 21. The device of Claim 12, wherein the quinoxaline derivative has Formula VI(m) shown in Figure 11.

22. The device of Claim 12 wherein the quinoxaline derivative has Formula VII, shown in Figure 12, wherein:

15 R⁴ and R⁵ are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, aryl, heteroaryl, alkylenearyl, alkenylaryl, alkynylaryl, alkyleneheteroaryl, alkenylheteroaryl, alkynylheteroaryl, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d, or both of R⁵ together may constitute an arylene or

20 heteroarylene group;

R³ is the same or different at each occurrence and is selected from a single bond and a group selected from alkylene, heteroalkylene, arylene, heteroarylene, arylenealkylene, and heteroarylenealkylene;

25 Q is selected from a single bond and a multivalent group;

a, b, c, and d are 0 or an integer such that a+b = 2n + 1, and c + d = 5;

m is an integer equal to at least 2;

30 n is an integer; and

p is 0 or 1.

23. The device of Claims 1-22, wherein the device is a light-emitting diode, a light-emitting electrochemical cell, or a photodetector.